

E. Lamp gives the following ephemeris for Berlin midnight (*Ast. Nach.*, 3338).

	R.A.	Decl.	Bright-
	h. m. s.		ness.
March 12 ...	19 45 30	+5 12'8	0'09
14 ...	45 0	5 46'4	
16 ...	44 25	6 20'2	0'09
18 ...	43 44	6 53'9	
20 ...	42 56	7 27'7	0'08
22 ...	42 3	8 1'7	
24 ...	41 3	8 35'7	0'08
26 ...	39 57	9 9'8	
28 ...	38 45	9 44'0	0'07
30 ...	19 37 26	+10 18'2	

COMET PERRINE-LAMP.—The revised elements of this comet, which have been arrived at by Dr. Lamp, indicate the following places for Berlin midnight (*Ast. Nach.*, 3338):—

	R.A.	Decl.	Bright-
	h. m. s.		ness.
March 12 ...	3 1 59	+48 34'4	0'15
14 ...	15 11	47 41'2	0'12
16 ...	26 9	46 51'8	0'10
18 ...	35 25	46 6'5	0'08
20 ...	43 21	45 25'4	0'07
22 ...	50 17	44 47'9	0'06
24 ...	56 25	44 13'9	0'05
26 ...	4 1 53	43 43'1	0'04
28 ...	6 51	43 15'1	0'03
30 ...	4 11 22	42 49'4	0'03

The unit of brightness is that of February 15'7. On March 14 the comet will be nearly 2° south of α Persei.

ORBIT OF δ CEPHEI.—From an investigation of the displacement of the lines in the spectrum of δ Cephei, Dr. Belopolsky came to the conclusion in 1894 that the light changes of this short period variable are closely associated with an orbital movement (*NATURE*, vol. li. p. 282). The results have been generally confirmed by another series of photographs which were taken last year, but there are some differences in the numerical data (*Ast. Nach.*, 3338). For the velocity of the system towards the sun the later value is 15'2 English miles per second, and the time of periastron passage is altered from 1'05 days after minimum to 0'9 days. The following data for the construction of a curve of velocities of the bright star relatively to the dark one, with which we must suppose it to be associated, are derived from the figures given by Dr. Belopolsky:

Interval from minimum in days.	Relative velocity in Eng. miles per sec.
0'8 ...	+13'4
0'5 ...	+7'8
1'0 ...	-1'8
1'5 ...	-10'6
1'7 ...	-11'5
2'0 ...	-12'9
2'5 ...	-10'6
3'0 ...	-6'5
4'0 ...	+1'4
5'0 ...	+8'3

A + sign indicates a movement in a direction away from the sun, and a - towards the sun. The period of revolution is equal to that of the light changes, 5d. 9h., and the maximum occurs 1d. 15h. after the minimum. At the time of minimum the stars lie very nearly along a line at right angles to the line of sight, so that the reduction of light cannot be produced by an eclipse.

Attention is drawn to several notable differences in the intensities of the lines in the star spectrum and in the spectrum of the sun. Mr. Lockyer has also recognised such differences, and has shown that the spectrum of δ Cephei is practically identical with that of γ Cygni, a star of increasing temperature; four other variables of the δ Cephei class have also been shown to give a similar spectrum.

THE ABSOLUTE VELOCITY OF 61 CYGNI.—The combined results obtained for the proper motion of a star by meridian observations, and for the velocity in the line of sight by the spectroscopic method, enable the absolute velocity and direction of movement to be determined. Dr. Belopolsky has recently applied this to the brighter component of 61 Cygni, employing the velocity derived from spectrum photographs taken at

Pulkowa. The mean velocity in the line of sight, corrected for the earth's movement, and thus referred to the sun, is 33'7 English miles per second towards the solar system. Taking the position of the apex of the sun's way as R.A. 267°, decl. +31°, and supposing the velocity of the solar system in space to be 9'3 English miles per second, the correction to be applied to 61 Cygni for the movement of the sun is 6'9 miles per second. Thus, the velocity of the star towards a fixed point in the direction of the sun is 26'8 miles per second.

Adopting a parallax and proper motion of 0''5 and 5''2 respectively, the linear velocity across the line of sight will be 30 miles per second, or, when freed from the velocity of the solar system, 22'6 miles. The resultant absolute velocity is accordingly 35 miles per second, the direction of movement having a position angle of 61° and being inclined at an angle of 140° to the line of sight.

ON THE APPEARANCE OF THE SPECTRAL LINES OF CLEVITE GAS IN STELLAR SPECTRA.

IT is very rarely that so rapid progress is made as that which followed Prof. Ramsay's discovery of the line in the yellow, corresponding with the solar line D₃, in the spectrum of the gas obtained from the mineral cleveite. As early as May 9, Mr. Lockyer communicated a paper to the Royal Society,¹ in which a table was given showing that many of the unknown lines in the stars with few lines in their spectra were really due to the new gases. It seems to take some considerable time for English work of this kind to get to Berlin, for on October 24 Prof. Vogel made the same announcement to the Berlin Academy.² His confirmation, therefore, is of great interest.

It is not a little curious that the first star which he discusses is not one of the stars in Orion to which Mr. Lockyer had specially referred, but to β Lyrae, which the same observer had demonstrated a year or two ago to be a double star, the spectra of the components resembling that of Rigel and Bellatrix, both in Orion.

Vogel found that a comparison of the lines of this star with those in the spectrum of cleveite gas showed in an unexpected manner a great number of coincidences.

His attention having been directed, in this perfectly independent manner, to the question, he was led to examine the spectra of many other stars, and to this end he employed the rich material collected by Dr. Wilsing. In the communication to the Academy, Prof. Vogel gives only a general survey of the work, leaving a more detailed account for a later publication. The first series of stars investigated were those in the constellation of Orion, for there the line λ 447 $\mu\mu$ plays an important part. The comparison, the results of which are here given in tabular form, exhibited many coincidences; the lines of cleveite gas most common to the stars β , γ , δ , ϵ , ζ , λ , ν , π_3 , π_5 , ω of Orion were those of wave-length 382'0*, 388'9*, 402'6*, 414'4, 438'8, and 447'2*, those of helium being marked with an asterisk.

It was at first thought that, in consequence of the paucity of stars of the Orion type in other parts of the heavens, few would be found exhibiting the lines of cleveite gas. An examination, however, of 150 of the brighter stars of Class I. disclosed the fact that no less than twenty-five, in which the characteristic Orion lines, or, in other words, the lines of cleveite gas, were visible, were observed.

Prof. Vogel informs us that until the spectra of all the stars of Class I., down to about the 5th magnitude, have been obtained and examined, an accurate idea of the distribution of these stars in the sky cannot be formed. He further adds that a third part of this work is already accomplished. Some of the stars in which the lines in the cleveite gas spectrum are well pronounced are: 102 Herculis, ι Herculis, α Virginis, γ Pegasi, β Piscium, β Cephei, ι Herculis, ι Andromedæ, τ Herculis, ζ Draconis, η Leonis, ρ Pegasi, β Persei, η Aurigæ.

The above-mentioned investigation leads Prof. Vogel to form the following deductions with regard to stellar classification. These we give in full, remarking that while Dr. Vogel had previously classed the stars which now turn out to contain the helium lines with stars like Sirius, Mr. Lockyer had classed them apart.

¹ P.R.S., vol. lviii. p. 117.

² *Sitzungsberichte der Königlich-Preussischen Akademie der Wissenschaften zu Berlin*, October 24, 1895.

"By an inspection of the numerous spectra my opinion is strengthened that in arranging stars according to their spectra only general marked characteristics should be considered, and a rational classification can only be thought of if based on the supposition that the various stellar spectra indicate different phases of development.

"I think it is much to be regretted that, in the extensive spectroscopic examination of all stars down to about the seventh magnitude, which Pickering by means of an objective prism has undertaken, the classification of stars, based on no general grounds, but only according to the appearance of the spectrum, which is very often misrepresented by incorrect exposure, especially in the case of brighter stars, leads him to adopt sixteen classes, denoted by the letters A-Q."

On this it may be remarked that Mr Lockyer has already shown in NATURE that Prof. Pickering's classification is quite philosophical, and that, moreover, it brings stars together to which he also has assigned special places in his classification on account of their special features.

Prof. Vogel then continues:—

"The attempt, on the lines mentioned above, which I made twenty years ago, with regard to the classification of stellar spectra has for the most part been corroborated, in spite of the great progress of stellar spectroscopy during the last few years, namely by the fine detailed researches of their spectra by Scheiner.

"In relation to the stars of Class III., direct observation of the less refrangible part of the spectrum of the photograph is yet to be considered. Of my two suggested divisions, *a* and *b*, the criterium as to which belongs to the more advanced stage of development is entirely absent. One can only say this, that in both divisions the atmospheres of the stars have so far cooled as to stop the dissociation of the materials and allow compounds to be formed. There is therefore, no reason given why stars of Class III.*b*, in which chiefly the absorption bands are produced by carbon compounds, should be placed in a special Class IV. For the same reason direct observation is a good means of recognising spectra of Class II. Also here there is no reason to adopt subdivisions other than the two already assumed by me before we are in possession of more accurate investigations of the spectra of Class II.*b*.

"It is different in the case of the spectra of Class I. In these spectra the application of photography makes it in general possible to step further and obtain more minute points of difference than was the case before. It appears also that the study of the spectrum of these stars is of special interest, inasmuch as, starting from the simplest spectrum, in which only hydrogen lines are visible, the first traces of a further development can be found by the appearance of lines of other substances, and we can follow them up to the numberless lines exhibited in the spectra of Class II. Perhaps it will be possible by a more extended investigation of the details of the spectrum of Class I. to find the first beginnings and individual parts of both from successive series, the extremities of which, so different in appearance, are spectra of the type of Class III.*a* and III.*b*.

"The observations mentioned above have led me to the opinion that the appearance of the lines of cleveite gas in stellar spectra, if closely watched, may give us a good basis for the classification of these spectra.

"The spectrum appearance of cleveite gas has such a similarity with that of hydrogen, as has long been known to be the case, through the constant appearance of the D₃ line with the hydrogen lines at all parts of the chromosphere of the sun, as well as in the prominences, that one may expect to find, after the appearance of the hydrogen lines in the first place, that of the lines of cleveite. The paucity in lines of the spectrum of this gas makes it especially easy to be at once recognised. Although the brightest line, $\lambda 388.9 \mu$, as already mentioned, falls so near constantly the present hydrogen line H ϵ in the spectrum of Class I. that a separation is impossible, and although in only very few cases does the sum-total of both these strong lines appear distinct—as, for instance, in the spectrum of β Lyra—the lines $\lambda 382.00 \mu$, $\lambda 386.8 \mu$, $\lambda 402.6 \mu$, and $\lambda 447.2 \mu$, on the other hand, and those in the less refrangible part of the spectrum, namely $\lambda 492.2 \mu$, $\lambda 501.6 \mu$, and D₂, $\lambda 587.6 \mu$, are so easy to find and recognise that the proof of the presence of cleveite gas is not beset with difficulties.

"As a second point of difference for subdivisions of Class I. the presence of the calcium lines $\lambda 393.38 \mu$ and $\lambda 396.86 \mu$ is convenient, the second of these lines coinciding nearly with

the hydrogen line H ϵ ($\lambda 397.02 \mu$). If the first of these lines be thin and sharp, the second only influences the hydrogen line H ϵ to a very small extent. If the lines of calcium increase both in intensity and breadth, then H ϵ broadens in a very distinct manner; both lines then very soon excel with respect to intensity and thickness, the strongest and broadest hydrogen lines in the spectra of Class I. On further development they form together the characteristic pair of lines in Class II. which Fraunhofer called H."

Prof. Vogel then concludes his paper with a re-division of stars of the first class into three parts, *a*, *b*, and *c*.

Although *c* includes stars having spectra which exhibit bright lines, he suggests that from the present point of view it would be perhaps better to place them first, as they represent the first stage of development. The fact that they are here retained in subdivision *c* is because a definite conclusion has not yet been arrived at as to their true position, so the old position has, *pro tempore*, been maintained.

THE RÖNTGEN RAYS.

THE following is a summary of some of the work with Röntgen rays brought under our notice during the past week:—

The results of a scientific study of the properties of Röntgen rays are stated in a paper by Prof. G. Vicentini and Dr. G. Pacher, in a paper read before the Reale Istituto Veneto di scienze, lettere, ed arti, on January 26, and now issued as an excerpt from the *Memorie* of the Institute (vol. xxv. No. 7). The authors found distinct evidence of an irregular reflection from a parabolic brass mirror; the Crookes' tube and the sensitive plate were placed on opposite sides of an iron plate, so that the rays to reach the plate had to be reflected from the mirror. No effect was observed with a similar glass mirror, or with the arrangements used by previous observers to test the existence of reflection. Photographs accompany the paper, showing shadows of fish, a hand, two feet, and a rat with mercury introduced into its intestines. Experiments showed that a gold-leaf electroscope, turned towards the kathode, became charged positively; a wire cage, however, completely annulled the action. The following list of transparencies to Röntgen rays is interesting:—Solid bodies (opaque): Potassium, phosphorous, fused sulphur, glass, sealing-wax, tin, zinc, iron, brass, copper, lead, platinum, mercury, crystallised sulphur, rock-salt, quartz, calc-spar, fluor-spar, topaz, beryl, aragonite, baryta, lead carbonate, tourmaline, borax. Semi-transparent: Aluminium, sodium, ebonite, retort-carbon, mica (along both axes). Transparent: Cardboard, wax, paraffin, sugar, wood-charcoal, amber, shellac. Liquid bodies (opaque): Carbon disulphide, sulphuric acid (saturated solutions of), sulphates of zinc, copper, iron, cobalt, nickel and magnesium, bichloride of mercury, chlorides of sodium, ammonium and platinum, neutral oxalate of potash, potassium bichromate, and ammonium nitrate. Semi-transparent: Acetic acid, nitric acid, glycerine, ammonia, and, in a less degree, distilled water and alcohol. Transparent: Ether, benzene, in a less degree vaseline, petroleum, aniline, and olive oil. There appeared to be no clear relation between the opacity and density of the substances experimented upon.

In order to get distinct shadows of objects opaque to Röntgen rays, it is obviously necessary to avoid a penumbra, by employing a source of the rays approaching as nearly as possible to a point. The Crookes' tubes, however, as usually put on the market, are given a pear-shape, for the purpose of having as extended an area as possible under the action of the kathode rays. To obtain clear shadows with such a tube the objects must be very close to the sensitive plate or the fluorescent screen, a condition which cannot always be realised if the objects are enclosed in envelopes of considerable thickness. Prof. E. Salvioni described to the Accademia Medico-Chirurgia di Perugia, on February 22, two methods whereby the kathode rays may be brought to a point on the walls of the tube, producing a very restricted but intensely fluorescent area. In Crookes tubes, with the usual spherical cup-shaped kathode, the rays issue from this normally, and meet in a point generally inside the tube. By moving a magnet in the neighbourhood of the tube, this focus may be brought on to the tube wall. A more convenient method of arriving at the same result was found by chance. On moving the hand over the tube, the position of the focus of the kathode rays is altered, and the same action takes place on touching the tube